Indonesian Journal of Electrical Engineering and Computer Science
Vol. 27, No. 3, September 2022, pp. 1557~1566
ISSN: 2502-4752, DOI: 10.11591/ijeecs.v27.i3.pp1557-1566

Guide to choosing internet of things protocols

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Article Info

Article history:

Received Feb 2, 2022
Revised Jun 14, 2022
Accepted Jul 3, 2022

Keywords:

Internet of thing
IoT
IoT protocols
Network protocols
Good practice

ABSTRACT

The internet of things (IoT) is a global infrastructure for the information society, enabling advanced services by interconnecting objects (physical or virtual) through existing or evolving interoperable information and communication technologies. Among the main keys to the IoT is the widespread adoption of clearly defined protocols. The implementation of its applications requires protocols capable of effectively managing these conditions, namely network protocols and applications. Considering the importance of using protocols in IoT applications, many protocols have been developed and used by various organizations according to their needs. However, choosing an adaptable, standard, and efficient protocol is a difficult decision, for all organizations and researchers. This difficulty, due to the complex nature of the IoT system and its requirements. Consequently, we propose a model for the use of IoT protocols based on criteria and metrics that will evolve the protocols. we call these models by the model of good practice of protocols of the Internet of things. Then, we implement these models in the form of a tool for choosing IoT (Networks and application) protocols. This study will allow researchers and developers to choose the appropriate protocols for an IoT application by allowing the result before the realization of the application.

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1. INTRODUCTION

The internet of things (IoT) is a modern concept that has invaded our professional and personal lives. The internet of things cuts across conceptual and technical dimensions. Conceptually, the internet of things characterises connected physical objects that have their own digital identity and can communicate with each other via computer networks. This network creates a sort of bridge between the physical and virtual worlds. These exchanges allow the best decisions to be taken in complex contexts. The widespread adoption of clearly defined communication protocols is a major key to the IoT. However, the diversity of network and application protocols offered on the scientific market by global organizations and researchers requires careful consideration to choose the right protocol for an Internet of Things application. Each protocol must be able to meet strict requirements. It must be able to provide functionality to the correct procedure. Then that 'there are several requirements that allow us to choose a protocol. We wanted to explore this issue further by proposing a tool for choosing IoT protocols. According to our research on software developed for the Internet of Things, we do not find any tools that analyse IoT protocols. There are a few methods of choosing IoT protocols.

First, Guide proposed by Jacksonville Daily News (JDN). JDN is a French online newspaper. It offers the best news from several areas, especially trendy IT subjects [1], namely: E-business, FinTech, Big Data, IoT, media trends, decision-makers. Choosing the most suitable communication network to link their

connected objects to the Net can become a headache. There are dozens of different technologies, each with its own particularities in terms of energy consumption or price. To help decision-makers avoid getting lost in this jungle, JDN offers an overview of the main solutions and presents their advantages and disadvantages [2]. In some situations, companies, researchers, and developers can torn between several different protocols. It is possible to combine different technologies on the same connected object, even if this makes the design of the device more complex. Guide in the form of several rests will be yes or no and from these replies, the researcher or the developer manually choose the protocol adaptable to their applications.

Then, the use of questions proposed by engineers or specialists. For this, we must answer a number of questions that will allow us to designate the optimal solution [3], [4]. Once we have answered all these questions, the choice of technology will seem natural to the user based on the analysis of these questions. Thereafter, there are Comparative studies, in the field of research, there are various comparative studies proposed by researchers and experts, which make it possible to choose a protocol manually. The document [5] provides a detailed comparative study of three network protocols: LoRaWAN, Symphony Link and Sigfox. Thus, it provides potential application scenarios.The major objective of the review article [6] is to provide a descriptive and comparative study of the LoRa, NB-IoT and Sigfox protocols in order to highlight the importance of low-power wide-area network (LPWAN) technology in the development and improvement of applications based on the IoT.

Kayal and Perros [7] presents a comparison of some network protocols. It focuses on the study of different characteristics of these protocols in relation to various measures namely the range and the data rate, the size of the network. Moreover, the goal of the comparative study realized in [8] is to evaluate and compare four communication protocols. To evaluate their response time by varying the traffic load. In the article [9], [10], the researchers present protocols used to connect objects but also end-user applications to the Internet. These comparative studies based on four criteria. Hasan and Jawad [11], they carry out a comparative study between the application protocol Message Queuing Telemetry Transport (MQTT) and hypertext transfer protocol (HTTP) to know the needs of a system, in particular the bandwidth requirements and the volume of data generated based on end-to-end throughput and delay. These previous studies are not yet finished and do not provide a deep insight into IoT protocols. Thus, they will not allow domain specialists to choose the right protocols for each type of IoT application [12], [13]. There are several criteria, which must be taken into consideration, and which will allow the evaluation of the protocols.

The phase of the study of the existing allowed us to highlight the following problems:

- A lack of application of choice of protocols in the market.
- There are many different protocols, which makes choosing between them difficult.
- Waste time choosing a good protocol by doing:
- An analysis of various comparative studies already carried out.
- An in-depth study between protocols by company experts.
- The existing methods of protocol choice are traditional and can produce errors.
- Using traditional methods takes more time.
- Cost issue, developers develop application and test protocols.
- Loses time in the choice of protocol.

Our tool would benefit researchers and developers in selecting an appropriate protocol for IoT applications. This tool allows for the comparison of protocols. It compares their main characteristics and behaviours according to different specific criteria to choose the suitable protocol for an IoT application.The computer development of our proposal realizes a tool to answer the greatest number of criteria, which evaluate an IoT protocol. Thus, this will make it possible to offer relevant solutions to ensure continuous operation. The remainder of this document is organize as shown in: Section 2 methodologie of work where we present our comparative study, then the operating models and thereafter the Good practice models. Section 3, we present our implementation of protocol choice tools. Next, We conclude the study in section 4 .

2. METHODOLOGY OF WORK

For the development of this tool, we spend by many steps. From the state of the art, the proposal of operating models, the proposal of models of good practice until the realization of the platform of choice of IoT protocols. That we will present in the following diagram in Figure 1.

2.1. Comparative study

We start our research by realizing a classification of almost all protocols according to the main layers of the IoT architecture. Then we focus on network and application protocols. Network protocols are one of the primary communication techniques for the internet of things. The protocol is the language used to establish communication between the various connected objects. To be able to communicate with each other,

two objects must therefore have the same communication language. They also exchange information via the internet. There are several protocols on the scientific market. We have classified the network protocols into three categories. the first for the short range protocols wae have: Bluetoot, Zigbee, NFS. The second for medium range: Z-Wave, WiFi, BLE. The thirt for the long range protocols we have: Lora, Cellular, Sigfox, Neul. For our comparative study of network protocols, we cited the criteria, which specified each of these protocols, which are: Specification, cost, energy, consumption, application, network, type, topology, Power, network size, throughput (Gbps), Frequency band, modulation, technique, spread, spectrum, range, security, data risk, and collision. This study assesses the capabilities of their main characteristics and behaviours in terms of various metrics of these protocols, in addition guaranteed an extensive study of these protocols. This work is already published in the article [14]. Thereafter, we only present the comparative table of network protocols.

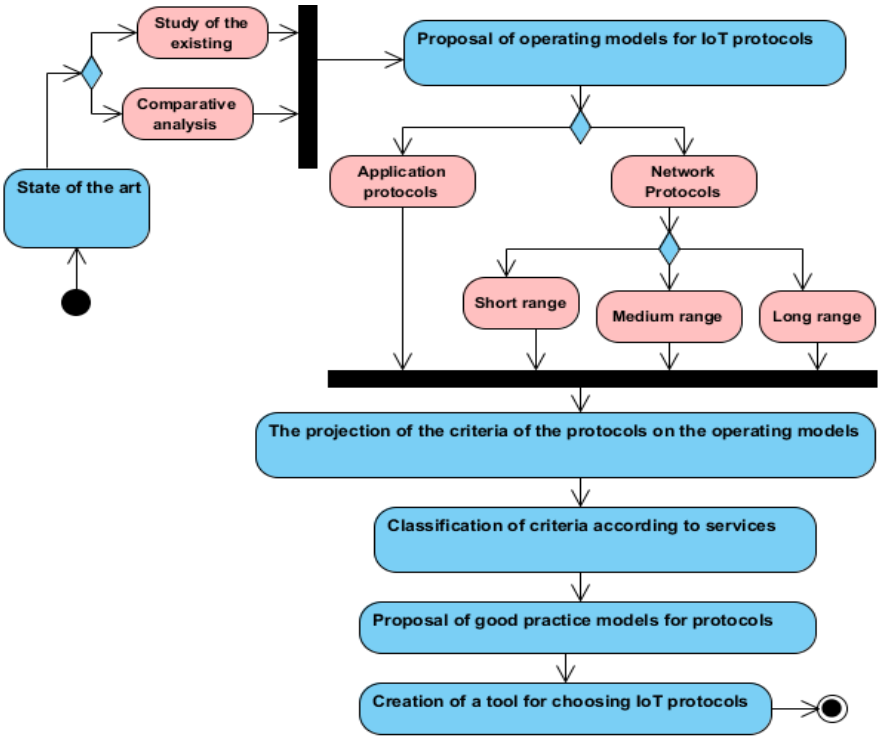

Figure 1. Methodology of work

2.2. Operating models

After the comparative study, we propose operating models for network and application protocols. These models facilitate an in-depth understanding of how network protocols work using the activity diagram, which divided into four parts. First, we realize the model of the operation of the application protocols [15] [16]. Then the long-range network protocols [17]. Subsequently, the short-range network protocols [18], [19]. Finally, medium-range network protocols [20]. After this realization, we project the criteria of these protocols, which are already quote on these models. Therefore, we have found that there several requirements allow us to evaluate a protocol. So our contribution and to be able to classify criteria, which evaluate the network protocols to your service are: General information, Network services and data management services. For the classification of application protocol criteria, there are four services in Table 1.

Table 1. The criteria service of network protocols

Service	Description	Criteria
General Information	General description	Specification, Application, Market Adoption, Cost, Energy needed,
Network Services	Management of the address format; Correspondence of addresses; Acknowledgment of receipt; The direction of the information flow; Sequence control; Flow management; Routing	Network type, Topology, Power, Network size.
Data Management Services	The management of the data format.; Detection of transmission errors; Information loss management; The direction of the information flow	Technical Modulation (MT), pread Spectrum (SP), Range (R), Security (S), Risk of data collision (RoC), Data Rate (DT),

2.3. Good practice

In this section we offer usage patterns protocols based on the criticisms already mentioned in the comparative study and in the operating models. We refer to these models as the internet of things protocol good practice models [21]. These models are to allow to select the appropriate protocol according to the characteristics of the application or the connected object before the realization. We realize four models of good practice of good practice for the protocol's networks according to the classification of these protocols. Thus, a model of good practice for application protocols. These models of good practice, which allows the choice of a protocol, based on the classification criteria according to the service and the measures of these criteria. We use this model and the other models proposed to implement a tool which allows the choice of a protocol easily and in a computerized way. The Figure 2 shows an example of the proposed models of protocol choices.

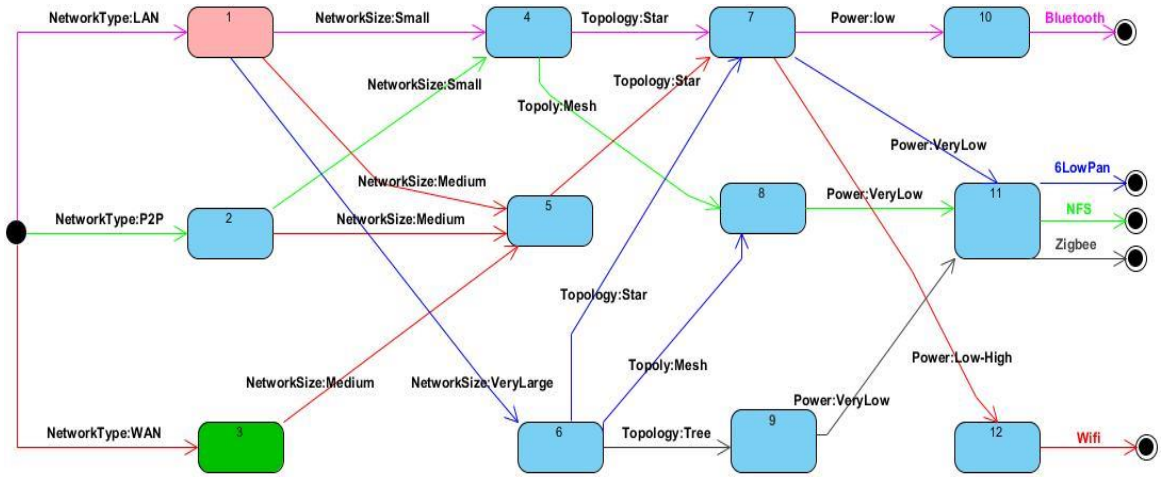

Figure 2. The small-distance: network services

3. TOOL PROPOSAL

These personalized models provide a broad and agile vision of network and application protocols. These models allow the choice of protocols based on a set of criteria, we have led to a solution that meets the objectives and overcomes the shortcomings observed in the existing process. Consequently, we propose a tool, which allows choosing the network and the application protocols adaptable to an IoT application. This choice will based on a set of criteria specific to the application. The proposed tool consists of three main models:

- Protocol selection based on a set of criteria.
- The choice of protocols based on the answer to the proposed questions.
- The choice of protocols from an XML file that will generate from a proposed model.

The tool must meet the following expectations:

- Choice module of Network protocols: By form, by question and by XML File.
- Choice module of application protocols: By form, by question and by XML File.
- Protocol management module: Add, Delete and Modify a protocol.
- User account management module: Add, Delete and Modify a protocol
- User simple task module: Access by authentification, See process, View sittings (Profile, Contact), Choose a Method
- Admin task module: Access by authentification, See process, Manage accounts and protocols, Choose a Method, Notification.

3.1. Conceptual study

Conceptual Study describes the design using the unified modelling language (UML) modelling language. We present the use case diagram. The diagram is to determine what each user expects from the system. The determination of needs based on the representation of the interaction between the actor and the system (Figure 3). Technical study will approach the technical side of the tool with exposure of the architectures used in our application also with the presentation of the technologies used.

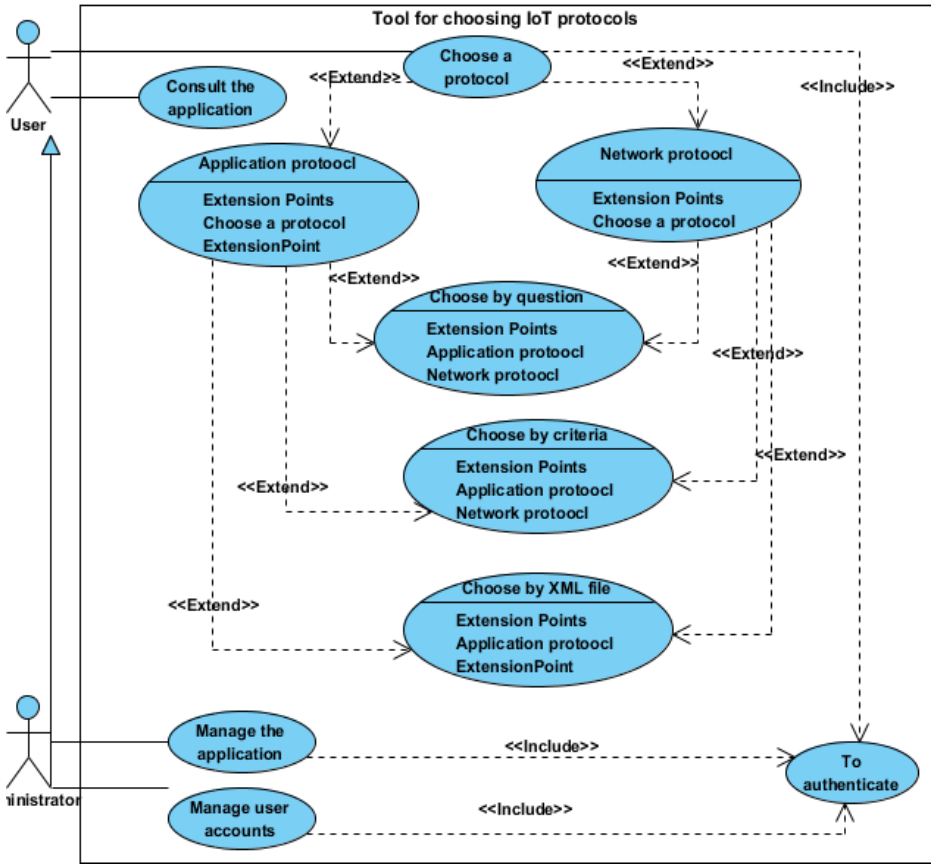

Figure 3. Use case of tool

The Figure 4 shows these technical requirements. The tool to produce must be able to meet a number of technical requirements, specifically: Security and authentication, the interfaces must be simple and the tool must be easy to use and the tool must be efficient and reliable. Figure 5 class diagram allows to schematize everything that we have seen to present the overall architecture of our system by clarifying the relationships between the classes. This digarmme presents the tables of our database. We integrate the protocols, the criteria as well as the measurements of each criteria from our comaparative study.

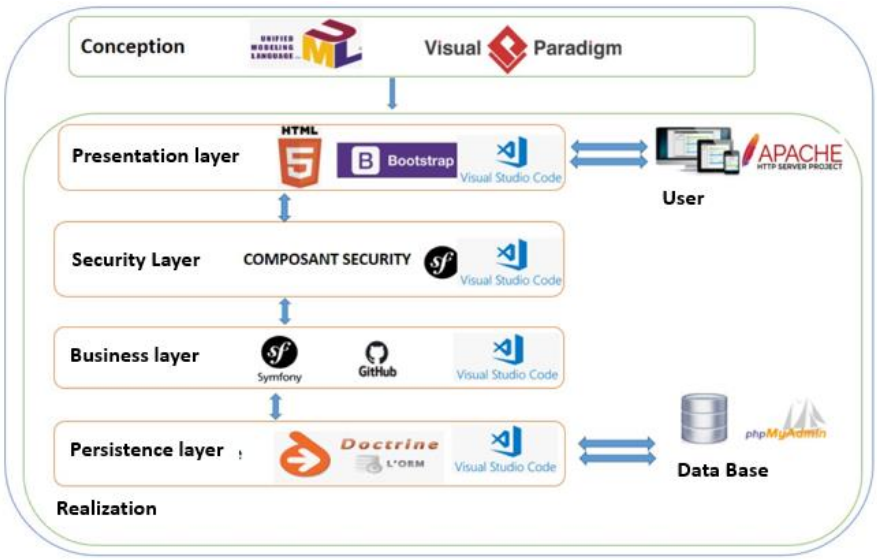

Figure 4. Technology uses

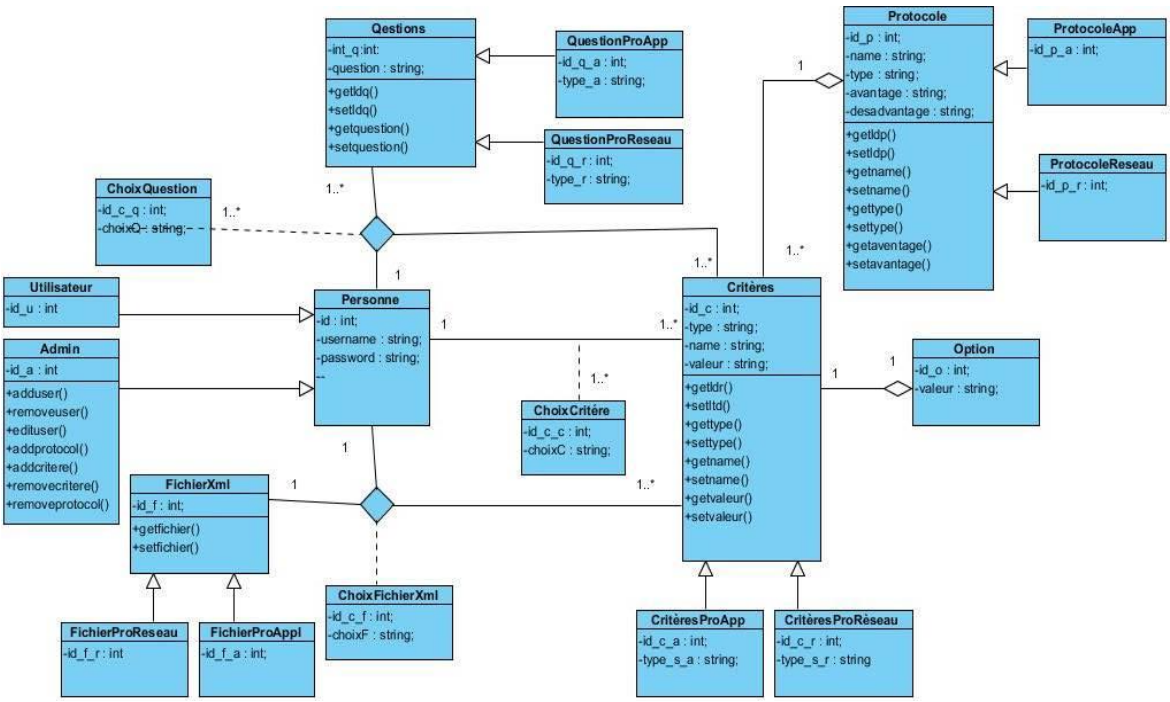

Figure 5. Class diagram

3.2. Network protocols

In this part, we present some interface of the tool.The first interface that displayed to users after logging in is the application home. To the left of the interface is an application menu. At the page center is general information about the Internet of Things and the application of choice for IoT protocols.

Choice of network protocol by criterion, this link will redirect you to a choice form by criterion. This form divide into three types of criteria: General information, Data criteria, and Network criteria (Figure 6). For the choice of network protocol by question (Figure 7), the tool will propose descriptive questions on the protocols, from the answers, we can have the protocol adapted to the IoT application.

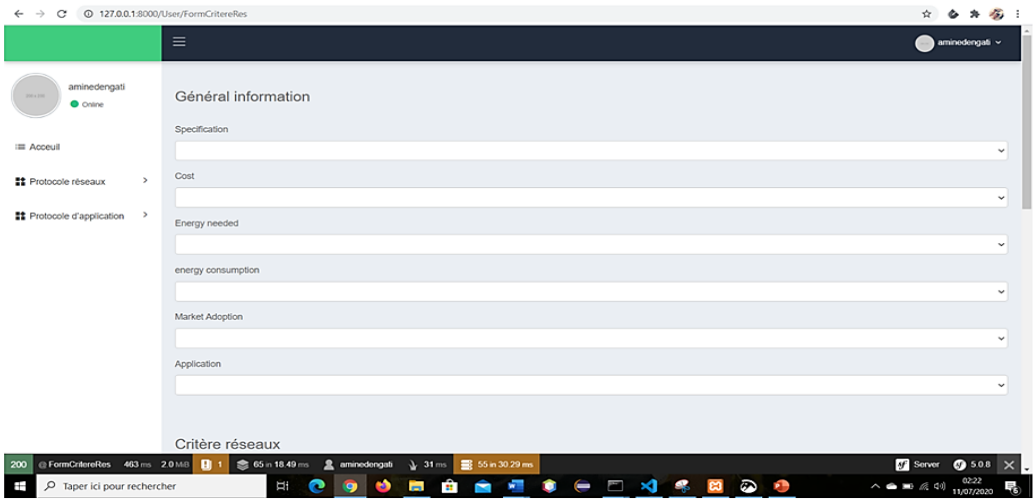

Figure 6. Choice of network protocol by criterion

After the user has completed the form and validated the data, the system will display the protocol adaptable to the user's need. The result in tabular form includes the name of the protocol, the advantages and disadvantages of the protocol (Figure 8).

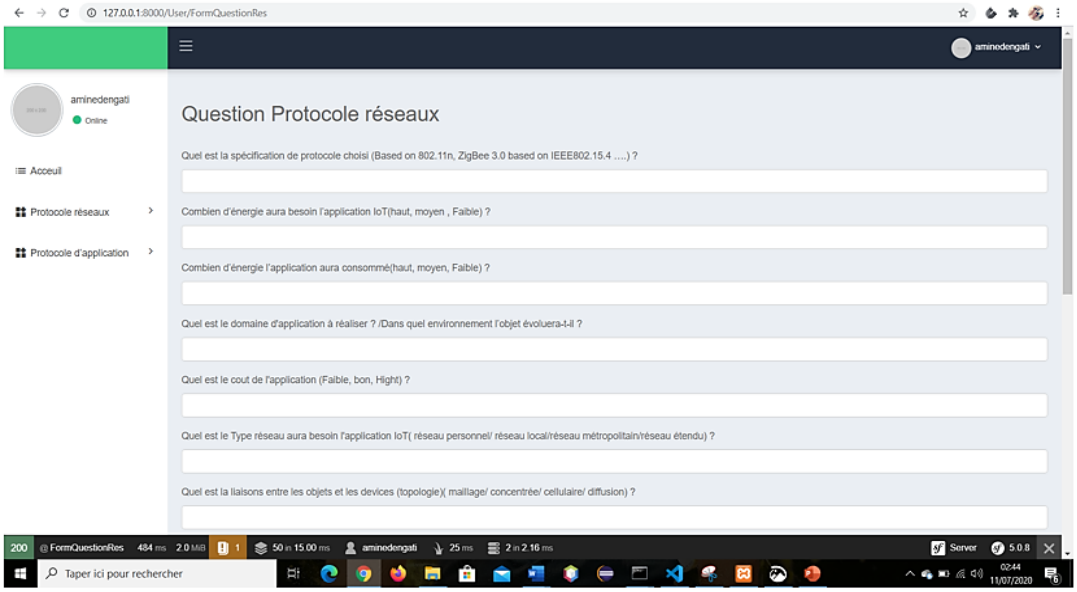

Figure 7. Choice of network protocol by question

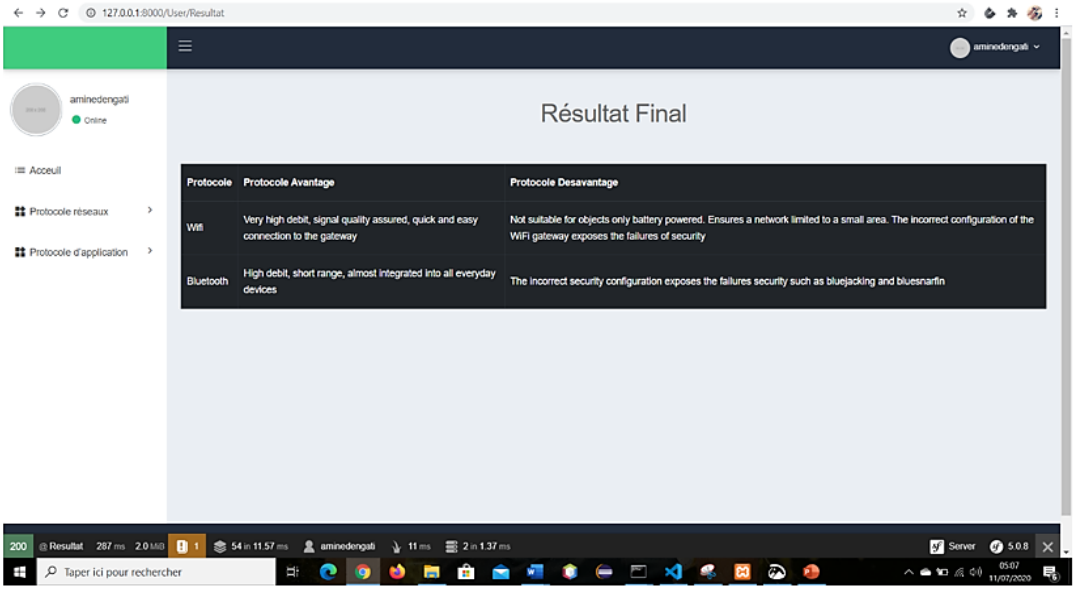

Figure 8. Result page

3.3. Protocol configuration

The administrator can view and add the list of protocols, the list of criteria, the list of questions, the list of options (the measures of the criteria) and the list of users. Which makes the tool open source and flexible. It suffices to add the new protocols with their criteria. As the tool allows the choice of network protocols, it allows the choice of application protocols by using the same principle.

4. TOOL VALIDATION USING CASE STUDIES

We use the cases of the articles shown in the following Table 2 to verify the results proposed by our realized tool [17]. We compare the choice results obtained by the tool and by each article. We find that these results are similar.

Table 2. Case study

	Articles	Protocols	Best protocol based on
1	Al-Sarawi *et al*. [22]	6LoWPAN, ZigBee, BLE, NFC, Z-Wave	Security, Low power consumption, Short range, Debit <= 1 Mbps
		SigFox et Cellular	Long range
2	Sinha *et al*. [23]	LoRa	Low cost, Battery life, capacity, and cost
		NB-IoT	High quality of service, Low latency, Reliability of range
3	Mollah *et al*. [24]	Bluetooth, ZigBee	Home automation application, the costs involved, Quality of service
		Z-Wave, Wi-Fi	,Medium range
4	Zbitou *et al*. [25]	ZigBee	Stable transmission time, Lowest energy consumption, The highest package delivery ratio,
			Can link any device to the internet, Medium Range

5. CONCLUSION

We produce a protocol choice tool which allows the choice of protocol adaptable to an IoT application before the application made. There is no doubt that meeting our need for a proposed protocol choice tool is one of the important factors for the success of this tool. Thereby, in this context, we have established a study of the existing methods used for the choice of protocols. Then, we put our working methodology, which consists of a detailed study of IoT protocols, the proposal of operating models of IoT protocols and good practice models of these protocols. Thereafter, analysis and design using different UML diagrams, until the proposal and implementation of an IT solution for the choice of IoT protocols. However, we can say that our tool of choice for IoT protocols still needs to improved and enriched by certain techniques and functionalities. In perspective, we intend to complete the implementation of the solution, by completing the developments with: Choice of protocols by XML file and integrate a decision tree for the choice of protocols.

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